SMART STREET LIGHT SYSTEM

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Abstract:

The "Smart Street Light System" project represents a cutting-edge solution to the urban lighting challenges faced by cities today. It leverages advanced technologies like sensors, wireless communication, and data analytics to create a highly efficient and responsive street lighting system. Traditional street lighting consumes significant energy and maintenance resources for municipalities. However, this innovative system can potentially reduce these costs by 50% to 70%. In the center of this system is the smart street light controller, which is mounted on each street light pole. This controller comprises a microcontroller, various sensors, and wireless modules. It intelligently manages LED street lighting based on factors like traffic flow and communicates crucial data between neighboring street lights. Wireless technology facilitates the transfer of data from these controllers to a central base station, enabling real-time monitoring and control. The system operates in two modes: automatic and manual. In automatic mode, it autonomously adjusts the lighting intensity and timing based on traffic and environmental conditions. It achieves this by employing infrared (IR) sensors to detect approaching vehicles and obstacles. When a vehicle or obstacle is detected, the street light illuminates, ensuring safety and energy efficiency. Once the vehicle or obstacle departs, the light extinguishes, conserving energy. The real-time status of each street light, whether it's on or off, is accessible through the internet. This within the core of conveniently monitor and manage street lighting from anywhere, at any time, via an internet connection. The "Smart Street Light" project not only promises substantial energy savings and reduced maintenance costs for cities but also contributes to a safe and more sustainable urban environment.

Keywords: Smart Street Light, Urban Lighting, Energy Efficiency, Sensors, Wireless Communication, Cost Reduction, Municipal Lighting, Maintenance Savings, Innovative Technology.

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1. Introduction

Project description:
Smart street light systems are an innovative approach to urban lighting, designed to optimize energy consumption, reduce maintenance costs, and enhance safety for pedestrians and drivers. This systemutilizes advanced technologies such as sensors, wireless communication, and data analytics toautomate the street's operation lights, making them more energy-efficient and responsive to the changing needs of the environment

Street lighting is an example of significant portion of a city's energy expenditure. Implementing a modernized system can lead to substantial cost reductions, often ranging from 50% to 70%. This innovative Intelligent street lighting is designed to adapt its illumination output based on usage and occupancy patterns. The core of this system is a street light controller, strategically installed on lamp posts. These controllers are equipped with microcontrollers, an array of sensors, and wireless modules. Their purpose is to oversee LED street lighting by responding to traffic conditions and facilitating data exchange between neighboring street lights. This data is subsequently transmitted to a central base station via wireless technology, enabling remote monitoring and management of the entire lighting network. The Smart city lighting systems provide two operational modes: automatic and manual. In the automatic mode, the system autonomously regulates the timing and intensity of streetlights based on real-time requirements. In contrast, the manual mode allows for manual control over the lighting system, affording flexibility to adapt to specific needs and preferences.

This system operates by detecting and responding to nearby vehicles using an infrared (IR) transmitter and receiver pair. When the sensors detect movement, they send data to a microcontroller, which then activates the street light. Conversely, when a vehicle or obstacle moves out of range, the street light is turned off, triggered by the sensor's detection. Additionally, the street light's status (ON/OFF) can be monitored remotely via the internet at any time and from any location.This project leverages smart embedded technology to efficiently control street lights based on the presence of vehicles or obstacles on the road. Whenever an obstacle is identified within the predefined timeframe, the street light will automatically switch on or off in response to the obstacle detection. This real-time status information (ON/OFF) for the street lights can be accessed from anywhere and at any time through the internet.

Literature Survey
The project is usually a multi-functional prototype that has a aptitude to get rid of the manual operation of the old street lightning system by strategy of the self-automation. Its goal is to plan and carry out cutting-edge embedded system development for energy-efficient street lighting and their maintenance at reduced cost with modern development. Street Lightning system has a feature as sensorsare used to detect the motion of the objects or vehicles.
In the realm of the Internet of Things (IoT), ESP8266 stands out as a top-tier integrated Wi-Fi chip due to its combination of exceptional performance and affordability. This Wi-Fi module boasts a 32-bit Tensilica Xtensa L106 microcontroller, which is embedded within it. Furthermore, it offers an impressive array of features within a compact PCB (Printed Circuit Board) footprint. These include components such as an RF balun, a low-noise receive amplifier, a power amplifier, various filters, and power management modules. Remarkably, ESP8266 accomplishes all this with minimal external circuitry.
In Automatic Street Light Control System is not only easy but also the powerful technique. Relay uses a automatic switch in this system. It releases the manual work almost up to 100%. Such type of system is also useful for reducing energy consumption. In this project is designed to detect the vehicle movement on the highways to switch ON only a block of the street light ahead of it and switch OFF the trailing light to save energy. During the night all the lights on the highways remain ON for the vehicle, but loT of energy is wasted when there is no vehicle movement on the highways.
The Wi-Fi ESP8266 MODULE is employed to upload to the important time information on the cloud through IOT panel. Providing a street lightning is one in every of the foremost important and expensive responsibilities of a city.

Technologies and Components Used

- **Ardunio UNO board:**

Fig 3.1: Ardunio UNO Board

Arduino is a widely adopted open-source platform designed for creating electronic projects. It encompasses two key components: a physical programmable circuit board, commonly referred to as a microcontroller, and a software environment known as an Integrated Development Environment (IDE). The IDE runs on your computer and is employed for writing and uploading digital code to the actual board. Button, LED, motor, speaker, GPS, camera, internet, and even your smartphone may all be controlled with Arduino. The Arduino UNO board is equipped with an array of features, including 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. Programming for the Arduino UNO is facilitated through the Integrated Development Environment (IDE), which stands for IDE, an acronym for Integrated Development Environment. It's worth noting that this platform can be utilized on both online and offline platforms to accommodate a wide range of user preferences and needs.

- **Breadboard:**

Fig 3.2: Breadboard

A breadboard (sometimes called a plugblock) is used for building temporary circuits. Abreadboard consists of plastic block holding a matrix of electrical sockets of a size suitable for gripping thin connecting wire, component wires or the pins of transistors and integrated circuits(ICs).

- **IR Sensor:**

Fig 3.3: IR Sensor

In the realm of infrared sensors, two primary types exist: active and passive. Active infrared sensors are unique in that they both emit and detect infrared radiation. These sensors comprise two essential components: a light emitting diode (LED) and a receiver. Their operation involves emitting infrared light from the LED, which subsequently reflects off an object and is then detected by the receiver. Active IR sensors are frequently employed as proximity sensors and find applications in obstacle detection systems, notably in robotic systems. An infrared sensor (IR sensor) is a radiation-sensitive optoelectronic component with a spectral sensitivity in the infrared wavelength range 780 nm …50 µm. IR sensors are now widely used in motion detectors, which are used in building servicesto switch on lamps.

- **LED lights:**

Fig 3.4: LED Lights

LEDs are light-emitting diodes is fundamentally a p-n junction diode that emits light upon activation. When a voltage is applied across its terminals, electrons can recombine with electron holes within the LED structure, resulting in the release of energy in the form of photons, which produces visible light. Hence, It has two leads and is a semiconductor light source.Our lighting system is made up of light-emitting diodes, and the quantity of light they generate is directly related to the amount of light in the surroundings, or when the amount of light outside is less than the amount of light inside givenby LEDS is more and vice-versa.

- **Jumper wires:**

Fig 3.5: Jumper Wires

Jumper wires are essentially wires equipped with connector pins at both ends, enabling them to establish connections between two points without the need for soldering. They are commonly utilized in conjunction with breadboards and various prototyping tools, simplifying the process of modifying a circuit as necessary. The concept behind jumper wires is straightforward and practical. In essence, they come in three main variations: male-to-male, male-to-female, and female-to-female, each distinguished by the type of connector at their endpoints. Male ends feature protruding pins, facilitating their insertion into compatible sockets, while female ends lack pins and are designed to accept plugs. Male-to-male jumper wires are the most prevalent and are typically used when connecting two ports on a breadboard, making them a staple in most prototyping scenarios.

Arduino IDE 2.0.3 :

Fig 3.6: Arduino IDE

The Integrated Development Environment (IDE) for Arduino is a freely available open-source software tool employed for writing and uploading code onto Arduino boards. This versatile IDE is compatible using several operating systems, including but not limited to **Windows**, **Mac OS X**, and **Linux**. It offers support for programming languages such as C and C++, making it accessible and adaptable to a wide range of development needs. Here, IDE stands for **Integrated Development Environment**.

In the Arduino IDE, the program or code you write is commonly referred to as a "sketch." To upload the sketch created in the Arduino IDE software to a Genuino or Arduino board, a connection between the board and the IDE is required. These sketches are typically saved with the '.ino' file extension.

The process begins with selecting the correct board and port settings within the IDE. A USB connection is used to link the board to the computer. Once these configurations are in place, you can initiate the upload process by clicking the Upload button located on the toolbar.

Modern Arduino boards often feature an automatic reset function just before uploading. In contrast, older boards require manual resetting by pressing the dedicated Reset button on the board itself. Successful uploads are indicated by the blink of the Tx and Rx LEDs.

In case of an upload failure, an error message will be displayed in the error window.

It's important to note that uploading sketches using the Arduino Bootloader typically doesn't necessitate any additional hardware. The Bootloader is a small program loaded onto the microcontroller of the board, and during the process, you may observe the LED blinking on PIN 13.

Analysis Design

System design:

In the Smart street light system where the Arduino board is attached to each component. using the jumper wires, the main component is the IR sensor that is reciever and transmitter sensor that is employed to detect movement of objects / vehicles. we are using the multiple sensors to detect the objects. Led lights are used for getting the lights that are in communication with the Arduino board using the jumper wires each sensor has the each led lights.

All these connection are formed with the help of breadborad which is used to make temporary connection. To limit the flow of current between the circuits we use the 220ohm registors. These registors are fixed on the breadboard to limit the flow. When the movement of objects or vehicles are detected by the sensor values becomes LOW that sendthe signal to the arduino that the light 1 is to be switched ON if the object moves away from the sensor the sensor value will be HIGH that indicates the light should be switched OFF.

Data flow diagram(DFD):

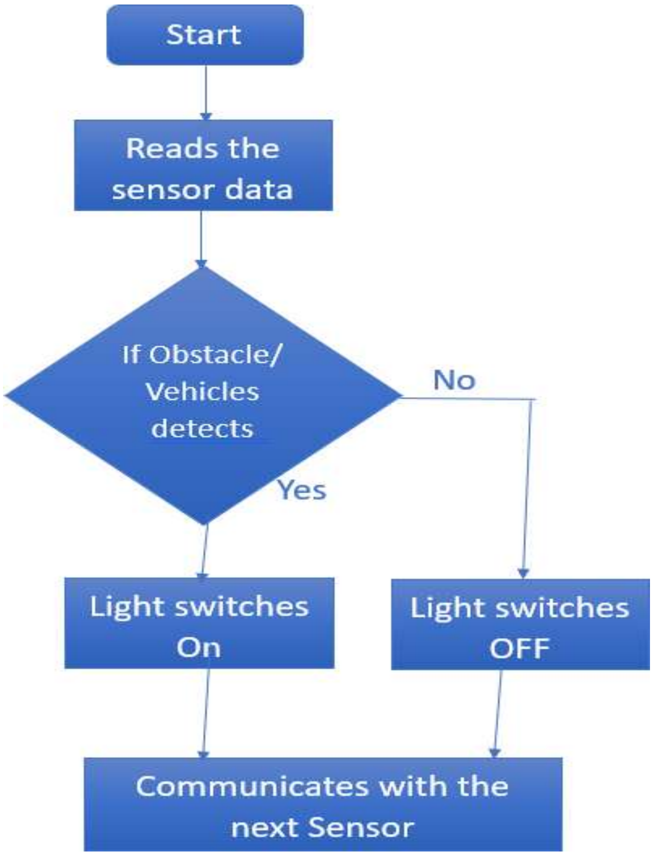

Fig 4.1: DFD

- **Circuit Diagram:**

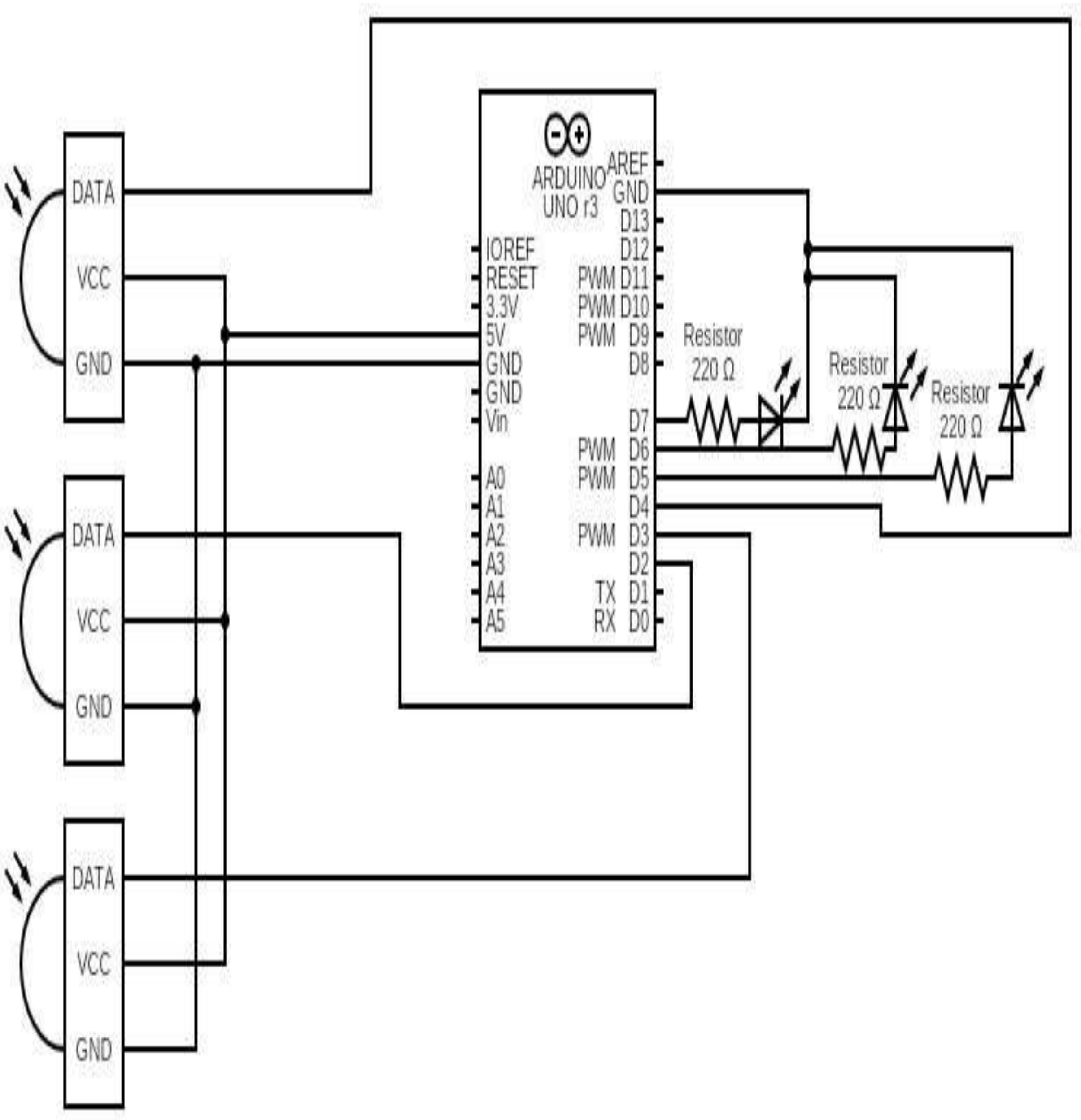

Fig 4.2: Circuit Diagram

2. Result

For running the code we use Arduino IDE 2.0.3 application , here we see the code is inserted and complied successfully

Fig 5.1: Testing

To upload the code firstly we have to select the Arduino uno board , and port when we connect the Arduino board to the system with the USB cable then the port will be shown. After selecting the port we select the upload option to upload the code to the board that makes the smart device work according to the instructions. We have made all the connections according to the circuit diagram and we are uploading the code to the board . if we are done wrong connections the the devices get heat otherwise it is ready to run the smart device Here we are using the battery to power supply and with all the components register 220ohm is used to control the flow of current among the connection.

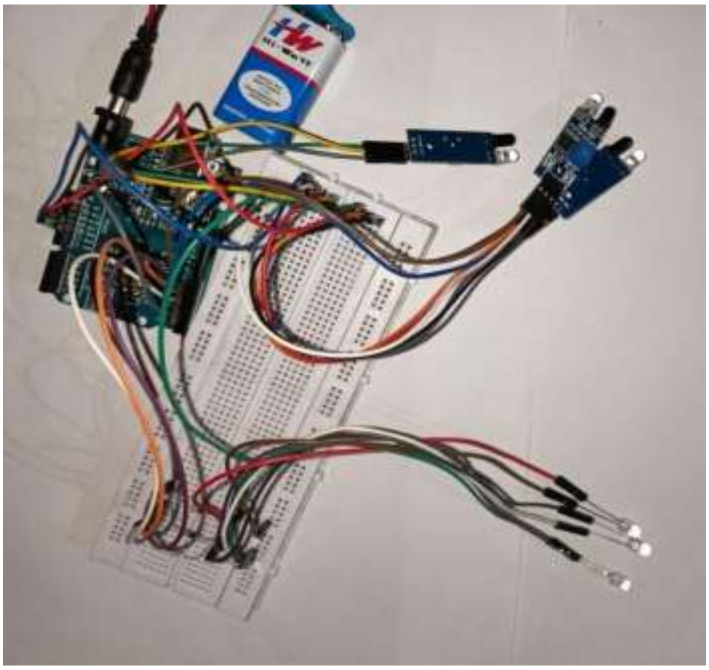

Fig 5.2: prototype

In the prototype we are using the three LED and IR sensors that detects the objects or vehicles and transmits the data to the board the makes lights switched ON

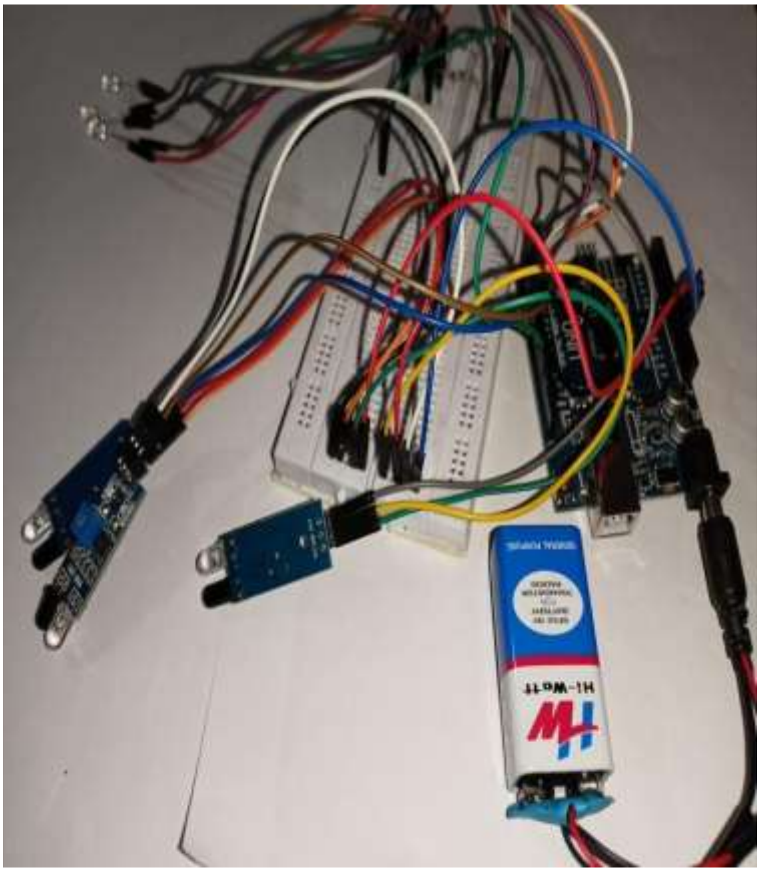

Fig 5.3: Prototype

Here when the object detects near the sensor the lights get switched ON automatically , when the objectmoves away from the sensor then the lights gets switched off automatically.

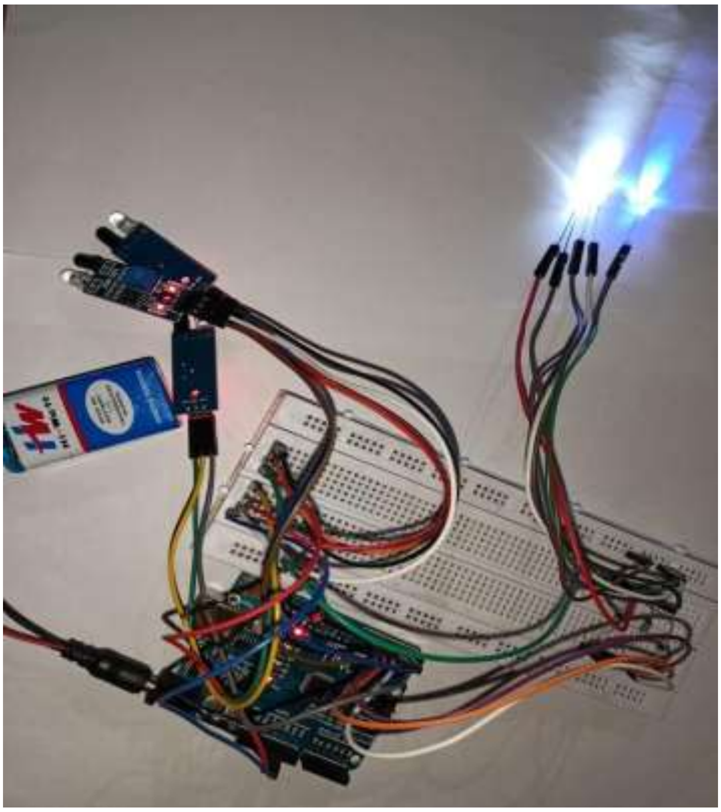

Fig 5.4 : Prototype

Advantages:

- Automatic Switching of Street lights.
- Maintenance Cost Reduction.
- Reduction in CO_2 emission.
- Reduction of light pollution.
- Wireless Communication.
- Energy Saving.
- Reduction of manpower.

1. Conclusion

Smart street light systems are a promising technology that can improve the efficiency, safety, and sustainability of urban lighting infrastructure. By using advanced sensors, data analytics, and wireless communication technologies, these systems can automatically adjust lighting levels and optimize energy consumption based on real-time conditions and user needs.

Overall, smart street light systems offer a range of benefits, including reduced energy costs, enhanced safety and security, and reduced carbon emissions. They also provide valuable data insights that can help cities make better decisions about urban planning, resource allocation, and infrastructure development.

However, the implementation of smart street light systems requires significant investments in technology and infrastructure, as well as careful planning and coordination among various stakeholders. Additionally, cities must address potential concerns related to data privacy, cybersecurity, and the social and environmental impacts of the technology.

Future Enhancement

There are several potential future enhancements that can be made to smart street light systems to further improve their efficiency, effectiveness, and impact. Some of these enhancements include:

Smart street light systems can be integrated with other smart city systems such as traffic management, air quality monitoring, and waste management. This can provide a more comprehensive approach to urban management and enable cities to make better decisions about resource allocation.

AI can be used to analyses data from smart street light systems and automatically adjust lighting levels based on factors such as traffic density, weather conditions, and pedestrian activity. This can optimize energy consumption and reduce operational costs.

Smart street light poles can be equipped with wireless charging technology to charge electric vehicles and other devices. This can promote the use of electric vehicles and reduce greenhouse gas emissions.

Smart street light systems can be powered by renewable energy sources such as solar panels and wind turbines. This can reduce reliance on non-renewable energy sources and reduce carbon emissions.

In conclusion, there are several potential future enhancements that can be made to smart street light systems to further improve their functionality and impact. These enhancements can enable cities to create more sustainable, efficient, and livable urban environments.

2. References

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